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## ABSTRACT

This paper discusses the Synagraphic Mapping System (SYMAP), a computerized cartographic planning tool, and describes its use by a large metropolitan junior college. The authors offer a brief introductory description of SYMAP and then discuss three possible uses of the system, illustrating their discussion with sample SYMAP-generated map displays. At an elementary level of usage, SYMAP can depict the geographical origins of students attending a college. At a more advanced level, these geographic origin maps can be used to compare similarities and differences between a college's primary and secondary catchment areas. For complex analysis, SYMAP can generate maps based on census data, which can be used by educational planners in conjunction with geographic origin maps to determine the best location for future college facilities within the college's overall service area. (Author/JG)

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COMPUTER CARTOGRAPHY--  
A NEW TOOL FOR INSTITUTIONAL PLANNING

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## ABSTRACT

With increasing concern over the geographical areas being served by institutions, computer cartography or computer-mapping presents a new tool for accurate spatial analysis. This study describes the use of SYMAP--Synagraphic Mapping System--a cartographic planning tool used by a large metropolitan junior college in the Southwest part of the United States. Unique features of this application include a simplified approach to SYMAP using zip codes and a three-fold level of usage adapted for the cartographic sophistication of the user. At an elementary level of usage, the computer-generated SYMAPS depicted the geographical origins of students attending the college, a striking improvement over the traditional "dot" maps. At a more advanced level, the geographic origin SYMAPS were compared to analyze similarities or differences of high catchment or density areas. For complex analysis, SYMAPS were generated using census data which, when compared with SYMAPS of geographic origin, enabled planners to visually analyze whether the north-northeast sector of the metropolitan region was best suited for a vocational-technical satellite center. The full application of SYMAP appears only limited by the interest in and availability of spatially defined data. Decisions affecting the location of a satellite center, recruitment approaches, community impact analysis or curriculum thrusts can be aided by this new cartographic planning tool.

COMPUTER CARTOGRAPHY--  
A NEW TOOL FOR INSTITUTIONAL PLANNING

Introduction

Planners on college and university campuses show increasing concern over geographical areas being served by their institution. In the late 1960's, administrators discussed ways to curtail enrollments that exceeded campus resources. Now, brief spot ads on TV and radio reinforce the "hard sell" mail and magazine enticements to students. With increased or stabilized enrollments in 1976, forecasters question what Lyman Glenny (1972, p.43) predicted: "What we can be sure about, however, is that enrollments as a whole are not likely to increase after 1977-78, and that for 10 or more years thereafter they will inevitably diminish." Given these dynamics of enrollment, computer cartography or computer-mapping appears to be an excellent new tool for the spatial analysis of campus service areas.

The speed and accuracy of the digital computer allows planners to analyze geographically distributed phenomena in ways heretofore not feasible because of limitations imposed by hand computation. For several years, computer cartography has received widespread acceptance in disciplines outside education. Most notably, city planners and geographers have mapped changing residential developments and traffic studies of delivery.

and routing problems in cities like Chicago using census data (Davis, 1972; Peucker, 1972). Interesting enough, the computer cartography program discussed in this study, Synagraphic Computer System--hereafter referred to as SYMAP and pronounced as in symbol--has been refined and tested in the field of architecture (Dudnik, 1971).

Educators have only recently begun to explore the full implications of computer cartography. In 1972, McIsaac, Costa, Spuck and Van Dusseldorp discussed the application of geocoded data to educational problems in the Milwaukee Public School District. Their areal analysis focused on redistricting to minimize overcrowded schools, identifying areas of economic deprivation eligible for ES&A Title I money, and providing support data for new school construction sites.

The Los Angeles Community College Data Project represents the only instance of geocode analysis and specifically, SYMAP, found in post-secondary education (Cherdack and Landini, 1974; Landini and Bannister, 1973). As one part of the project, Landini and Bannister (1973) developed computer-generated maps depicting the geographic origin of students attending the eight colleges in the Los Angeles Community College District. Additionally, they developed socio-economic maps using census data to help determine residence locations of disadvantaged persons.

Three technical tools were employed in map-generation: address coding guide (ACG), a method for recording on computer tape geographical codes for an urban map; ADMATCH, a package of user-oriented computer programs and documentation to assist in the assignment of geographic codes to computerized data records containing street addresses; and SYMAP. Aside from the mechanics of map development, written documentation from the project is extremely helpful in postulating alternative uses for computer maps. Cherdack and Landini (1974) suggest that maps can help decision-makers identify the need for specific programs by mapping employment patterns; identify the service area of colleges to eliminate unneeded student crossovers among institutions; aid in site selection for new campuses and provide valuable data to document specially-funded areas for grant proposals.

Unfortunately, these limited ventures into educational computer cartography fail to fully explore a simplified approach to SYMAP and to discriminate between levels of computer-mapping applicability for planning. This study proposes to remedy these shortcomings. A detailed application of SYMAP to the service-areas of a large metropolitan junior college is discussed. Two facets distinguish this approach from earlier educational applications: zip codes represent the unit of geographical

analysis rather than the extensive merging of data files and three alternative applications of the tool are suggested.

At the simplest level of application, SYMAPS can visually depict student origination areas within the college service area. In this way, they can replace the ubiquitous "pin" or "dot" maps that are time-consuming, costly and ambiguous. At the intermediate level, SYMAPS enable a planner to consider primary or secondary catchment areas of students attending the college and thus compare different service areas. Finally, SYMAPS can assist in determining potential pools of students by enabling one to visually compare maps portraying the geographic origin of current enrollees with maps of socio-economic data.

Later, these three uses of SYMAP will be discussed in detail with sample map displays. But first, a brief introduction to the SYMAP program will be made followed by a step-by-step outline of the application of the tool to the junior college in this study.

#### The SYMAP Program

The SYMAP program is available to a wide audience in post-secondary education through extensive documentation now available from the Laboratory for Computer Graphics and Spatial Analysis in the Graduate School of Design, Harvard University (Dougenik and Sheehan, 1975). Hardware requirements for this large 5000

cards + FORTRAN computer program are well within the means of most computer centers: a medium-sized computer--at least 225K--and a line printer. For centers with small memory computers, planners may want to explore the "scan line" approach developed by Scriptor (1969) that uses an algorithm embodied in a FORTRAN program of 114 statements and a core space of 8K. Using card input for SYMAP, the generated maps display spatially dispersed data of variable darkness.

Three basic mapping routines are available in the program: the conformant map, the contour map and the proximal map (Dougenik and Sheehan, 1975). Although one may wish to experiment with all three types of maps, the investigators in this study developed contour maps inasmuch as they seemed to best visually portray the continuous data by connecting all zip code and census areas having the same value.

SYMAP also provides data packages to create user-specified maps. For generating the contour maps in this study, the A-Outline, B-Data Points, E-Values, and F-Map data packages were used. Since the contents of each package can only meaningfully be discussed in reference to specific map output, these packages will be explained later as applied to the junior college in this study.

#### Steps in Map Development

A large metropolitan junior college used SYMAP to provide

additional data for planning decisions. This junior college, housed in one building in the central business district, has undergone phenomenal growth in the last few years. FTE enrollments increased by 11.1 percent between 1974 and 1975 (Oklahoma Higher Education Report, 1975). In the fall of 1975, students were turned away because of lack of space.

In past years, the institution has used tabular data and a "dot" map to visually display where the students live who attend the college. Since four types of students attend the college--parallel or transfer, vocational-technical, day students, and evening students--the first objective of this study was to produce accurate visual displays of the service area of the institution. Five maps, in total, were developed with the fifth map representing the geographic origin of all students. Next, a more sophisticated analysis was needed to determine what differences, if any, exist between primary and secondary catchment areas--high density areas--of two or more types of students. For example, were the vocational-technical students drawn primarily from areas different than the evening students? For this step, simple map comparisons of primary and secondary catchment areas were conceived.

Since the downtown campus faced burgeoning enrollments, a need existed to establish an extension or satellite campus center

in the metropolitan region. Institutional data suggested that the vocational-technical enrollments had grown considerably and that an extension center should meet this growth area. Furthermore, the northeast sector of the city was suggested as an ideal location to tap potential technically-oriented students. Two criteria for the extension center became apparent: (1) that such a center be located within easy commuting distance from currently enrolled voc-tech students and (2) that the area--at least by the standards of low income and low educational levels--hold the possibility of drawing potential vocationally-oriented students. In response to these criteria, two research questions were drafted: does the college currently attract vocational-technical students from the north-northeast sector of the city--and therefore students within easy commuting distance to a new facility and secondly, does the socio-economic status of that area indicate potential pools of voc-tech students?

To meet the three broad needs of the institution--identifying current service areas, high density areas, and the geographic placement of an extension center--called for the development of five SYMAPS of current enrollees and two socio-economic maps of income and educational level. The use of zip codes as the geographic unity described below provides a simplified approach to SYMAP well within the information available on most campuses.

Step 1. The A-Outline package of SYMAP calls for the definition of the study area or map area in which data values will be displayed and interpolation take place. In this study, the investigators obtained a large zip code map of the metropolitan area. Using a grid reference sheet, a list of vertices--X and Y coordinates--were identified in a clockwise direction for the outline of the metropolitan area noting where the outline changed directions.

Step 2. B-Data points are required for contour maps to specify the locations with data values. For this study, it was decided that zip codes rather than street addresses or counties would serve as appropriate geographical identifiers inasmuch as they defined an adequate area. Furthermore, zip codes are easy to obtain without extensive recoding required by other geographical units. Next, the approximate center for each zip code area was determined and the X and Y coordinates plotted using the grid reference sheet. For the socio-economic maps, the center of census tracts was used for the coordinates.

Step 3. The E-Value package of SYMAP associates data values with each data point. The junior college computer center provided cards indicating how many students resided within each of the zip code areas. Furthermore, these cards were divided into five decks--all students, parallel students, voc-tech students,

evening students, and day students. These values, the number of students in each zip code area, became the data values associated with the geographic X-Y data points. For the socio-economic maps, the data values associated with each X-Y census tract were taken from the 1970 Census of Population (U. S. Bureau of the Census of Population).

Step 4. In the SYMAP program, thirty-eight F-Map electives are available for use depending on the map output desired. The F-Map package enables a user to specify the precise form of the printed output. The most important specifications include the size of the map, the number of value class intervals, the range of values--maximum and minimum--and a general labeling of the map. In this study, the largest map was specified--a width of thirteen inches--for current enrollee maps and nine inches for the socio-economic maps. Six levels of density were specified for most of the current enrollee maps and five levels for the socio-economic maps. These levels and the range of each level appear in the legend accompanying the map. General background information was also added to describe the map to a viewer.

#### Sample Output and Discussion

Due to limited space, only the output related to vocational-technical students will be discussed. Also, only a brief treatment of analysis for each figure will be made.

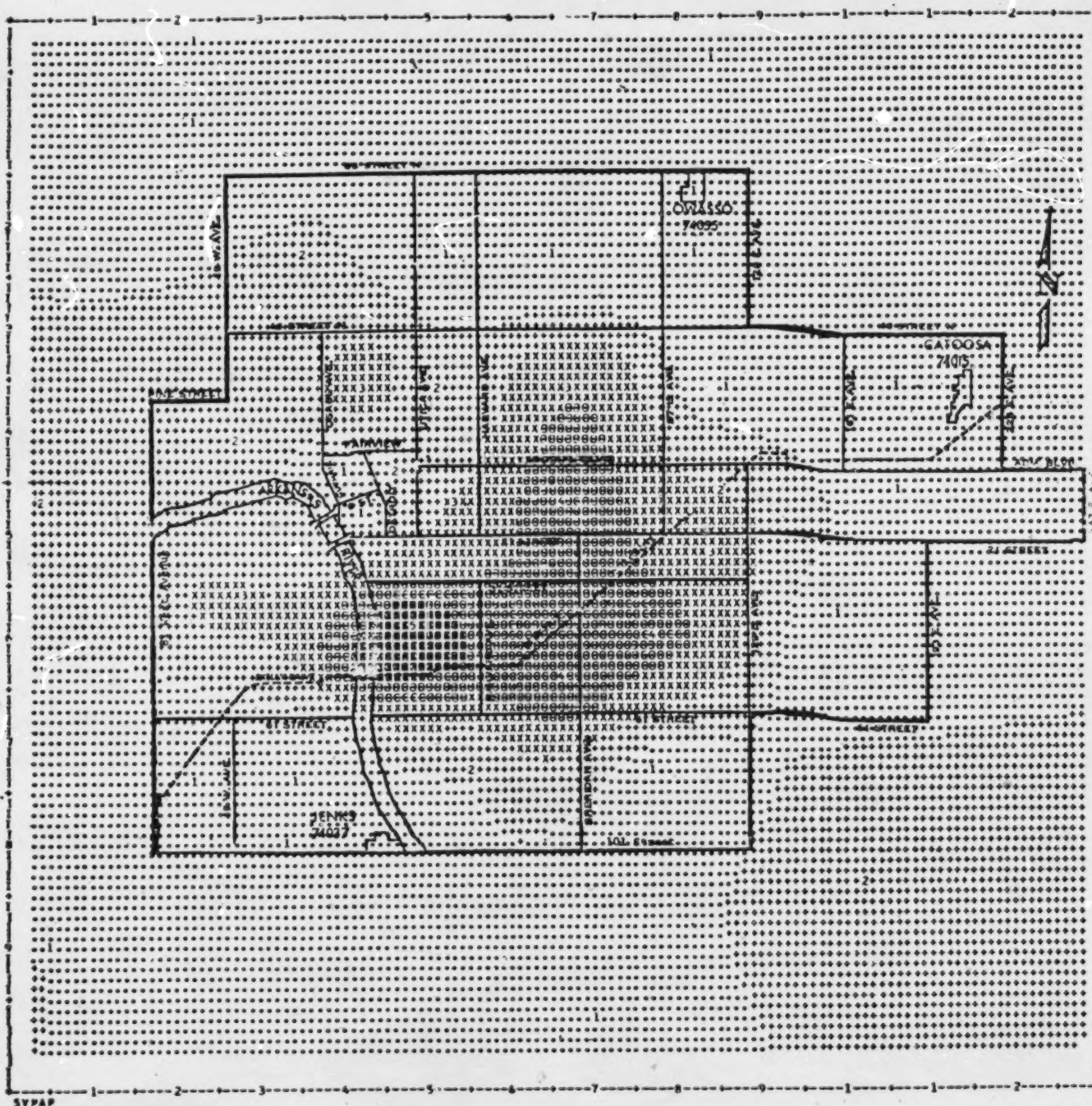
To accurately portray the areas being served by the institution, geographic maps were produced. Figure 1 presents a sample geographic origin SIMAP for vocational-technical students enrolled in the junior college for the fall of 1974. A transparency overlayed the map indicates streets, zip code areas and a major river. An accompanying legend, not shown in this figure, identifies six levels of density based on fifty-student intervals. The darker the symbol on the map, the greater the number of students attending the junior college from a particular area. As one can see, the highest concentration of vocational-technical students live in the central part of the metropolitan region.

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Figure 1.

Figure 1.

SYMAP FOR VOC-TECH STUDENTS ENROLLED  
IN THE JUNIOR COLLEGE WITH OVERLAY



By tracing the boundaries of the most dense areas of students on the geographic origin maps and superimposing a transparency of streets, one can note differences in the primary and secondary catchment areas--high density areas--of students. Figure 2 presents such an analysis comparing catchment areas for vocational-technical students and all students. From this visual analysis, one can see that the primary catchment areas for vocational-technical and all students are similar, both groups being drawn primarily from an area just south of the central business district. However, an analysis of secondary catchment areas shows a different trend. More vocational-technical students are drawn from the north-northeast sector of the city than all students. This finding suggests that a northeast-based satellite campus may be within minimum travel distance from a large group of vocational-technical students.

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Figure 2.

Figure 2.

MAP COMPARISONS OF PRIMARY  
AND SECONDARY CATCHMENT  
AREAS OF VOC-TECH AND  
ALL STUDENTS

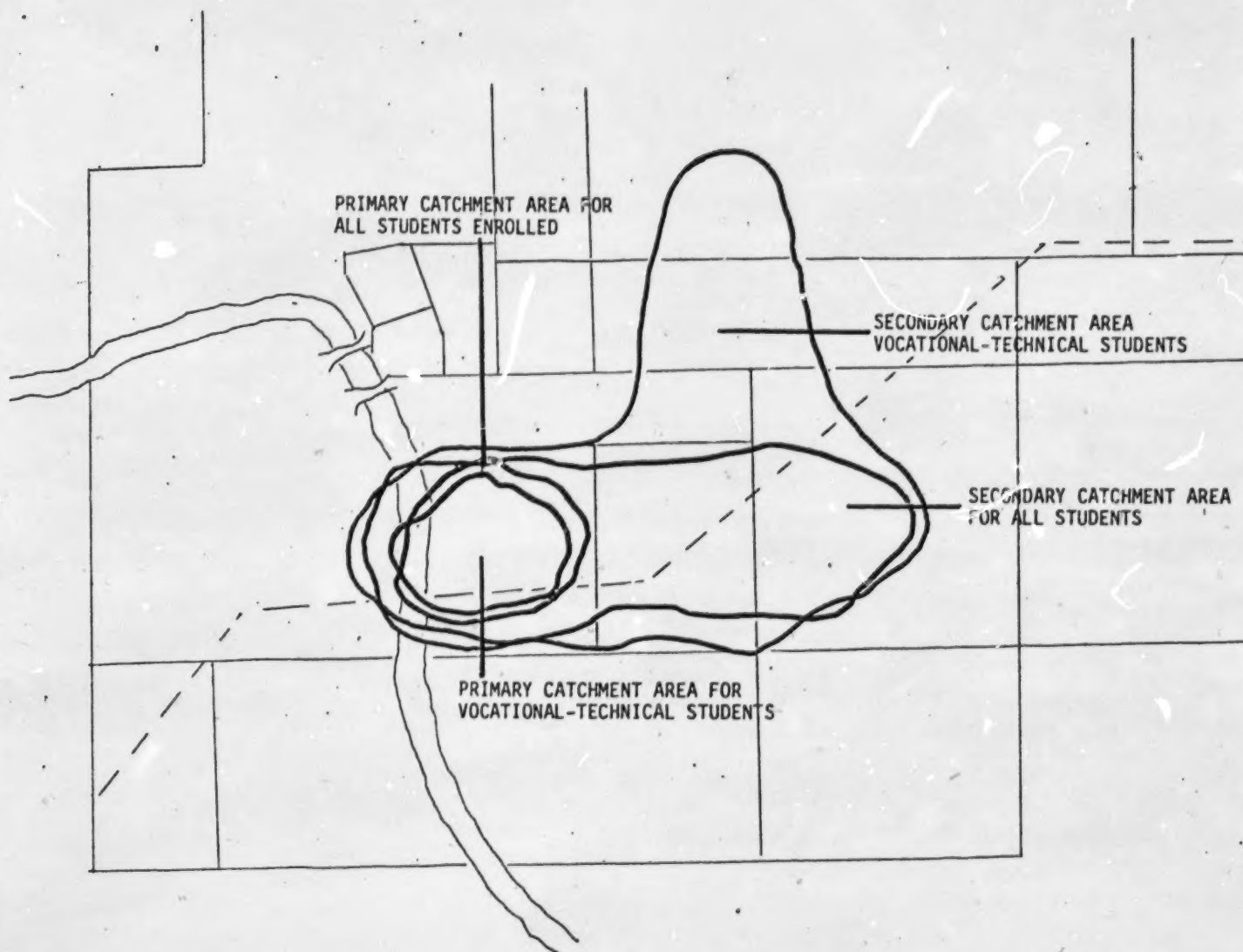


Figure 3 presents a SYMAP indicating the median income of families living in the metropolitan area by census tract. Particularly in the north-north central portion of the region one finds low income families -- from roughly \$7,000 to \$10,000 per year. Using the symbols below the map, a "1" symbol means that families in the area earn from zero to \$6900 per year; a "2" symbol means that they earn from \$6900 to \$8700 per year; a "3" symbol means that they earn from \$8700 to \$10,200 per year; a "4" symbol means that they earn from \$10,200 to \$12,900 per year; and a "5" symbol means that they earn from \$12,900 per year to \$23,600 and above per year.

At this point in the analysis, if one were to place the geographic origin map of vocational technical students and the secondary catchment configuration next to this median income map, a visual inspection can assist in determining whether a satellite center should be located in the north-northeast sector of the region. Referring to the criteria for locating the center mentioned above, it does appear that the northeast sector can minimize the travel distance of the vocational technical students as well as draw potentially vocationally-oriented students from low income neighborhoods that are likely to provide vocational technical students.

Figure 3.

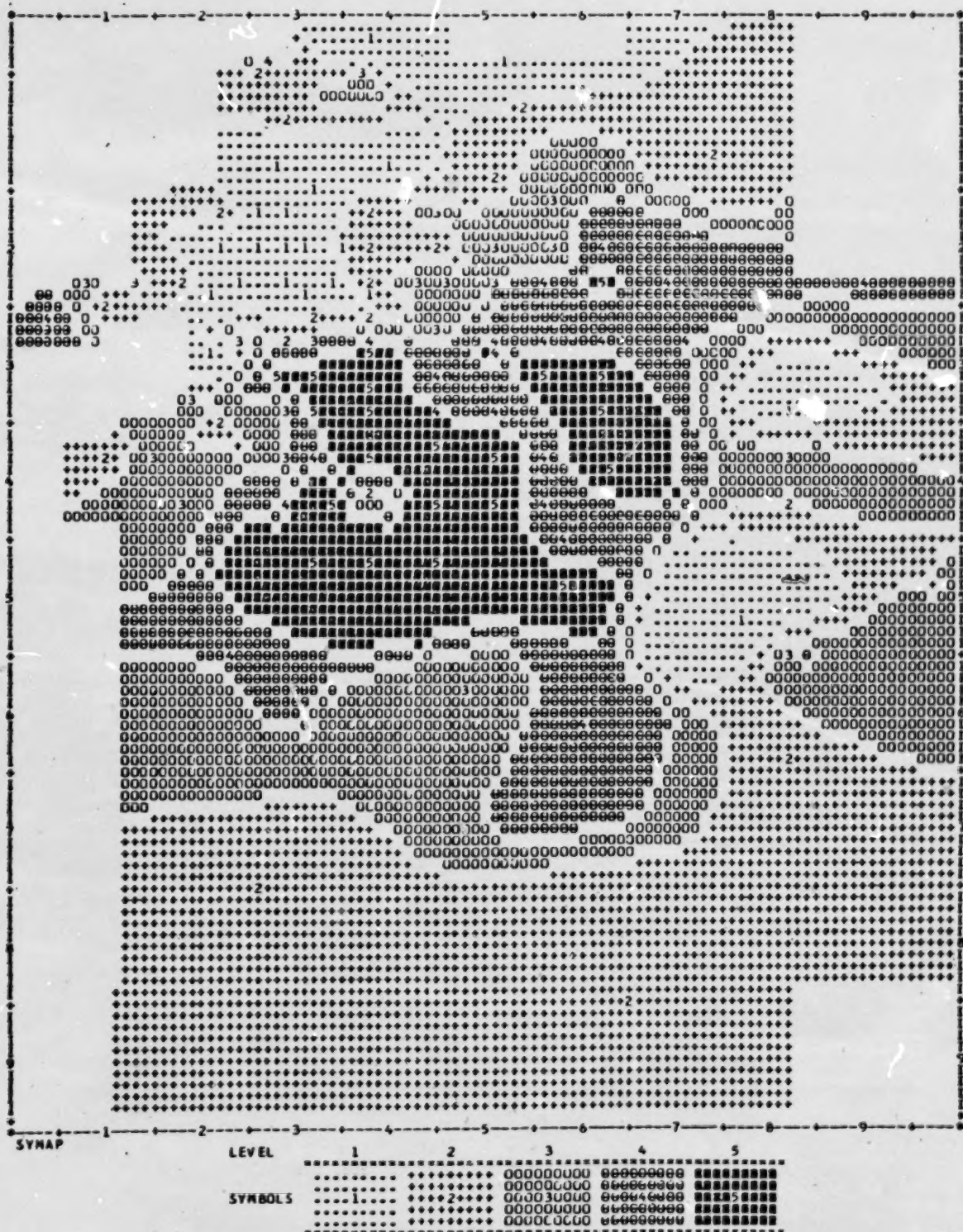
### Conclusions

Alternative uses of SYMAPS seem only limited by the interest in and the availability of spatially-defined data. Their usage, however, is not intended to displace other valuable data that contributes to a decision. But they do cast data in a lively form, a visual form, an alternative to the ambiguous tabular data that often confronts a decision-maker.

Figure 3.

## SYMAP OF MEDIAN INCOME

USING CENSUS DATA WITH PARTIAL LEGEND



This study suggests that cartographic mapping and specifically, SYMAP, is within the capability of most institutions. With the above format, SYMAP can be used at increasing levels of sophistication. Furthermore, the use of zip code areas as the unit of geographical analysis extremely simplifies map development. With the approach taken in this study, junior and senior colleges should examine computer cartography as a new management planning tool.

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